(11) (A) No. 1032825

(45) ISSUED 780613

(52) CLASS 99-81
C.R. CL.

(19) (CA)

CANADIAN PATENT

(54) COFFEE PERCOLATION PROCESS

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Granted to General Foods Corporation,
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(21) APPLICATION No. 213,465
(22) FILED 741112

(30) PRIORITY DATE U.S.A. (417,337) 731119

No. OF CLAIMS 8 - No drawing

ABSTRACT OF THE DISCLOSURE

In a percolation process wherein a coffee extract is produced by countercurrently extracting roasted and ground coffee with an extraction liquid in a series of extraction columns, the extraction columns are capped at the top and bottom with an inert filler material. This process results in improved coffee yields due to more efficient extraction. The preferred inert filler material is spent coffee grounds.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A percolation process wherein roasted and ground coffee is countercurrently contacted with an aqueous extraction liquid in a series of vertical extraction columns, and wherein said extraction liquid is fed to and withdrawn from said extraction columns through fluid inlet and outlet distributors located at the top and bottom of said columns, said roasted and ground coffee being confined to a position between said fluid distributors and filling the remaining liquid inlet region of each column to a height equivalent to at least 0.5 L/D (length/diameter ratio of the column) with an inert material and filling the remaining liquid outlet region of each column to a height sufficient to cover the outlet distributor with inert material.

2. A process according to Claim 1 wherein said extraction columns comprise a main cylindrical section and upper and lower conical sections and wherein said fluid distributors are located in said conical sections.

3. A process according to Claim 1 wherein said inert packing material is spent coffee grounds.

4. A process according to Claim 3 wherein said spent coffee grounds are dearomatized.

5. A process according to Claim 2 wherein said roasted and ground coffee is confined to the cylindrical portion of said extraction columns.

6. A process according to Claim 5 wherein said inert packing material is spent coffee grounds.

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7. A process according to Claim 2 wherein said fluid distributors are bayonets.

8. A process according to Claim 7 wherein said inert packing material is spent coffee grounds.

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This invention relates to coffee and more particularly to a percolation process wherein soluble coffee solids are extracted from roasted and ground coffee to produce a coffee extract which is further processed into soluble coffee powder.

Percolation is the semi-continuous countercurrent extraction of soluble coffee solids from roasted and ground coffee. The extraction process is performed in a percolator set which is a series of extraction columns, generally 4 to 6. At steady-state operation, the extraction columns contain roasted and ground coffee of varying degrees of extraction. An aqueous extraction liquid, generally water, is fed at elevated temperatures to the entrance of the extraction column containing the most extracted coffee in the percolator set, typically referred to as the spent stage extraction column. The extraction liquid passes through this column extracting soluble coffee solids from the coffee contained therein, exits this column, and is passed to and through the next successive extraction column containing the next most extracted roasted and ground coffee in the percolator set. In a similar manner the extraction liquid is passed through successive extraction columns containing progressively less extracted or fresher roasted and ground coffee extracting soluble coffee solids therefrom. Finally, the extraction liquid is passed through the extraction column containing the least extracted roasted and ground coffee in the percolator set (generally fresh, unextracted roasted and ground coffee). This column is typically referred to as the fresh stage extraction column. A pre-determined quantity of extraction liquid is drawn-off from this column as coffee extract, thus completing a cycle, which is then further processed to produce a dry soluble coffee product. The coffee extract will typically contain between 20% - 35% soluble coffee solids by weight.

A new cycle is begun by taking the spent stage extraction column from the previous cycle off stream and placing an extraction column generally containing fresh unextracted roasted and ground

coffee on-stream thus becoming the fresh stage extraction column for draw-off of coffee extract for this cycle. Aqueous extraction liquid is then fed to the spent stage extraction column for this cycle, the coffee contained therein being the next most extracted coffee in the previous cycle, and the process continues as before with extraction liquid passing through extraction columns containing progressively less extracted roasted and ground coffee and finally being drawn off as coffee extract from the fresh stage extraction column.

In this manner, then, a given bed of roasted and ground coffee becomes progressively more extracted with each cycle. (Cycle being defined as the period between successive draw-offs of coffee extract from the fresh stage extraction columns.)

An understandably important consideration in the coffee percolation art is to maximize the yield of soluble coffee solids obtained from a given charge of roasted and ground coffee. Unique to percolation, however, is the desire to avoid impairment of the characteristic flavor and aroma constituents of coffee so that the final soluble coffee product will more nearly resemble fresh-perked roasted and ground coffee. This factor often must be balanced against yield maximization. Thus, for example, the use of extremely high temperatures, while useful in achieving high yields, is to be avoided since it will significantly impair and alter the delicate flavor and aroma characteristics of the coffee.

While numerous advances have been made in the art in achieving relatively good yields without substantially affecting product quality there exists a recognized need for further improvement in this area.

It has been discovered that percolation yield increases can be achieved by confining the roasted and ground coffee to be extracted to a position between the fluid distributers located in the top and bottom of the extraction column, and filling the remaining areas in the extraction column with an inert packing

material.

According to the invention there is provided a percolation process wherein roasted and ground coffee is countercurrently contacted with an aqueous extraction liquid in a series of vertical extraction columns, and wherein said extraction liquid is fed to and withdrawn from said extraction columns through fluid distributors located at the top and bottom of said columns, said roasted and ground coffee being confined to a position between said fluid distributors and filling the remaining upper and lower areas with an inert packing material.

The percolator set used in extracting soluble solids from roasted and ground coffee is comprised of a series of vertical extraction columns connected by appropriate manifolding to permit extraction liquid to flow into and out of a particular column and into successive extraction columns. The extraction columns are fitted with fluid distributors located at the top and bottom of the extraction column through which the aqueous extraction liquid is fed to and withdrawn from the extraction column. Whether the top or bottom fluid distributor is the inlet or outlet distributor is of course dependent upon whether the particular column is being run in the upflow or downflow position.

The term "fluid distributor" is intended to broadly describe any apparatus used to flow extraction liquid into the extraction column and through which extraction liquid is flowed out of the column. Generally, the fluid distributors are designed as perforated screens or sheets which allow extraction liquid to enter and leave the column but which retain the roasted and ground coffee within the extraction column.

The most typical and satisfactory fluid distributor employed in commercial percolation processes is the bayonet which is essentially a perforated tube. The use of the bayonet and an example of a suitable structure is described in Sivetz and Foote, Coffee Processing Technology, Vol. I, pp. 269-271 (AVI 1963).

The bayonet protrudes into the extraction column and is generally perforated only in the portion protruding into the roasted and ground coffee bed.

The extraction columns of the percolator set are generally cylindrical vessels fabricated from steel. The top and bottom of the extraction column are fitted with valves to allow roasted and ground coffee to be loaded into the extraction column and to be discharged therefrom after having been fully extracted. Because of this necessity, the extractor liquid inlet and outlet fluid distributors enter the extraction column from the side. Further, so as not to interfere with column filling and discharging the fluid distributors must be located at some distance away from the extreme top and bottom of the extraction column.

It has been discovered that percolation yield increases can be obtained by positioning the roasted and ground coffee to be extracted between the upper and lower fluid distributors. It has been found that when roasted and ground coffee is allowed to fill the entire extraction column those portions of the roasted and ground coffee lying above and below the upper and lower fluid distributors is less efficiently contacted with the aqueous extraction liquid and hence is not as fully depleted of soluble coffee solids as desired. By confining the roasted and ground coffee to be extracted to a position between the extraction liquid inlet and outlet fluid distributors more efficient contact and extraction of the roasted and ground coffee is achieved resulting in higher percolation yields and hence more economical operation without affecting the quality of the coffee extract obtained.

For the purpose of the ensuing description of this invention reference will be made to the bayonet apparatus typically employed in commercial percolation processes. However it is to be understood and will be apparent that the process of this invention is equally applicable to other extraction liquid inlet and outlet fluid distributor means.

The roasted and ground coffee to be extracted is confined to a position in the extraction column between the upper and lower bayonets and the remaining upper and lower areas in the column are fitted with an inert packing material.

The inert packing material should be one in which there is little or no extractable material since some extraction, albeit inefficient, will occur in the areas above and below the upper and lower bayonets. Examples of such materials are the commonly-employed column packings such as Raschig rings, Berl saddles, Pall rings, and the like. Examples of these and other packings may be found in Perry's Chemical Engineer's Handbook, 18-26 (4th ed. 1963).

A particularly useful packing material is spent coffee grounds defined herein as roasted and ground coffee which has been fully extracted during the percolation process. While there is by definition little extractable material in spent coffee grounds they may contribute undesirable aroma and flavor notes to the ultimate coffee extract. Accordingly, when spent coffee grounds are employed as the inert packing material it is preferred that they be first "de-aromatized," that is, treated to remove substantially all their aroma and flavor. This may be accomplished generally by contacting the spent coffee with temperatures in the order of 200°F to 300°F. It may also be desirable to first contact the spent grounds with water to remove any extraction liquid remaining thereon.

In order to obtain the benefits of this invention the minimum requirement is to provide inert packing material within the column to just cover the upper and lower bayonets, i.e., such that the roasted and ground coffee is confined to a position immediately above and below the lower and upper bayonets. Thus, the extraction column is filled with the packing material to just cover the lower bayonet; roasted and ground coffee is then loaded to a point just below the upper bayonet, and the remaining area

to the top of the column is filled with the inert packing material. When operating in this manner it is found that increased yields can be achieved due to the absence of roasted and ground coffee being in areas of the extraction column which are inefficiently contacted with extraction liquid.

It may also be desirable to employ the packing material at levels higher than those above-mentioned. It has been found that the roasted and ground coffee around the bayonet is exposed to less efficient extraction liquid contact due to inefficient liquid flow distribution resulting in fingering or channelling of extraction liquid resulting in a bypass of areas of roasted and ground coffee. By providing an inert packing material at the extraction liquid inlet area, proper flow distribution development can occur before the extraction liquid contacts the bed of roasted and ground coffee. Proper flow distribution as used herein is merely intended to describe flow patterns of liquid through the solid bed of material which do not exhibit significant channelling and bypassing of material.

The amount of packing material needed in the extraction liquid inlet area may be easily determined by those skilled in this art by visual observance of the flow patterns. As a general consideration, however, the packing in this embodiment is employed from the top or bottom of the column (depending upon whether extraction liquid enters the column from the top or bottom) to a distance of at least 0.5 L/D (length/diameter) from the top or bottom of the column.

In this embodiment, then, assuming an upflow of extraction liquid, the packing material is loaded to, say, 0.5 L/D above the bottom of the column, roasted and ground coffee is then loaded to just below the upper bayonet and inert packing is used in the remaining upper area to the top of the extraction column. The loading sequence would be reversed for downflow operation.

While the above process achieves significant yield

increases it has been found that practical considerations dictate utilizing the flow distribution criteria in both the top and bottom of the extraction column. In percolation processes it may be necessary to reverse-flow an extraction column if excessive pressure problems are experienced or it may be desirable to alternate flow in one or more of the extraction columns in later cycles. For these reasons it is desirable to pack the column such that proper flow distribution is achieved regardless of the direction of liquid flow and without the need for unloading and reloading the extraction column.

While the present invention and the specific embodiments set out above does not depend for its success on any particular extraction column design, it will be appreciated by those skilled in this art that the extraction column typically used in commercial percolation processes is a vertical column having a main cylindrical section and upper and lower conical sections. An example of this type column is shown in Sivetz and Foote, Coffee Processing Technology, Vol. I p. 264 (AVI 1963). The bayonets or other suitable inlet and outlet fluid distributors are located in the conical sections of the extraction column. The bayonets may extend only part way across the column but in order to withstand the force of coffee discharge when the spent stage extraction column is blown down it may be practical to extend the bayonet to the opposite wall of the extraction column.

When this type extraction column is employed, the inert packing material is employed according to the numerous embodiments given above. As a general rule of thumb, the packing material need be employed no higher than the end of the conical section of the extraction column in order for proper flow distribution to develop prior to contact with the roasted and ground coffee to be extracted confined in the cylindrical portion of the extraction column.

The aqueous extraction liquid of this invention, while

generally water, may also be a solution of salts or soluble solids such as coffee solids. Generally the extraction liquid is fed to the spent stage extraction column at temperatures in the range of 300°F to 350°F and it is desirable to draw off coffee extract from the fresh stage extraction column at temperatures below about 220°F. Suitable intercolumn heaters or coolers may be employed according to methods well-known in the art to achieve any desired temperature profile.

The roasted and ground coffee of this invention may be decaffeinated or undecaffeinated and may be a single coffee variety or a blend of coffee varieties.

The following example will serve to illustrate the advantages of the present invention.

EXAMPLE

A single extraction column having upper and lower bayonets positioned in the conical sections was loaded with 400 grams of Berl saddles to just cover the lower bayonet. 1362 grams of fresh roasted and ground coffee were then loaded into the column to just below the upper bayonet and 400 grams of Berl saddles were used to fill the remaining top area of the column. Exhaustive extraction of this column was performed using a temperature profile increasing from 210°F to 350°F over 192 minutes. The yield for this run was 65.0% on a dry basis computed as the percent solids drawn off in the coffee extract divided by the dry weight of the coffee load.

A control run using the exact same operating conditions but with the extraction column completely fitted with fresh roasted and ground coffee resulted in a yield of 59.9% on a dry basis.